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CURIOSITY IN THE EDUCATIONAL ENCOUNTER, A REPRESENTATION OF DANIEL E. BERYLNE.

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THIS PAPER PRESENTS A SUMMARY OF BERLYNE'S THOUGHT ABOUT CURIOSITY AND COGNITIVE CONFLICT AS MOTIVATIONAL FACTORS IN KNOWLEDGE-SEEKING BEHAVIOR. THE SUMMARY IS BASED UPON FOUR OF BERLYNE'S WORKS THAT WERE SELECTED AS "CORE" TO THE DEVELOPMENT OF HIS THOUGHT. THIS PAPER CONCENTRATES UPON BRINGING OUT THE SIGNIFICANT DIFFERENCES OF THE SELECTED WORKS. THE AUTHORS DISCUSS BERLYNE'S CLASSIFICATION OF MOTIVATIONAL FACTORS, TYPES OF MOTIVATION OF EXPLORATORY BEHAVIOR, THE DETERMINANTS OF EXPLORATORY BEHAVIOR, THE ROLES OF SELECTED FACTORS (AROUSAL, CONCEPTUAL CONFLICT, EQUILIBRIUM, AND INFORMATION THEORY VARIABLES) AS DETERMINANTS OF HUMAN PERCEPTUAL CURIOSITY, AND EPISTEMIC (LEARNING) BEHAVIOR. THE AUTHORS CONCLUDE THAT A KNOWLEDGE OF THE EFFECTIVE USE OF CURIOSITY IN EDUCATIONAL PROCESSES IS NECESSARY FOR UNDERSTANDING INTELLECTUAL PROCESSES AND THAT THE WORK OF BERLYNE IS AN IMPORTANT RESOURCE FOR THOSE WHO WISH TO UNDERSTAND THE USE OF CURIOSITY IN EDUCATION. (AL)

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CURIOSITY IN THE EDUCATIONAL ENCOUNTER: A Representation of Daniel E. Berlyne

by
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Daniel E. Berlyne, Professor of Psychology at the University of Toronto, is enjoying a diverse and productive career as a potent influence on current psychological thought. He worked with Piaget in Geneva during 1958-59, and was instrumental in 1950 in translating Piaget's book, La Psychologie de L'Intelligence first published in France in 1947.

Of equal importance are Berlyne's lucid writing on motivation and the thought processes of human beings. The purpose of this paper is to represent Berlyne's thought upon curiosity and cognitive conflict as motivational factors in epistemic (knowledge seeking) behavior. Four of Berlyne's works were selected as "core" to the development of his thought. This representation of a major psychologist will by no means encompass the totality of his work, but the writers believe it provides significant direction for the interested student to initiate personal inquiry with the purpose of learning by discovery.

There is considerable overlap in the primary sources, since each revolves around Berlyne's interest in curiosity and human thought processes. To avoid redundancy the paper concentrates upon bringing out significant differences among the writings under consideration. It should be kept in mind that though there are four primary sources for this representation, there is one subject and each source provides support for Berlyne's conception of human thought.

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Berlyne (1965) states in his book, Structure and Direction of Thinking, that motivational phenomena generally fall into one or more of three classes, namely: activation (the degree of intensity of motivating factors necessary to keep the organism acting); direction (motivational factors that remove uncertainty left by a stimulus pattern associated with a number of alternative responses, and determine which of the several responses shall be performed); and reinforcement (the association of a particular stimulus or stimulus pattern to a particular response or response pattern, sometimes conceived in hedonistic--pleasant vs. unpleasant--terms and, at other times, within the homeostatic framework as a reduction of drive or tension).

Berlyne holds that the above three motivational factors may be specified to directive thinking. Activation in thinking appears to involve the degree of effort, concentration and force as related to persistence in thought and ability to ward off distraction and discouragement once a chain of thought processes is initiated. Direction in thinking encompasses the selection among alternative kinds of symbolic material at different levels. Reinforcement usually means the achievement of a symbolic sequence or pattern regarded by the thinker as sufficient for his needs, and appears to be analogous to goal attainment in motor activity. In thinking, the attainment may take the form of confirmation when a thought pattern resolves cognitive conflict.

In discussing the motivation of exploratory behavior, Berlyne distinguishes two types. Specific exploration, aimed at and reinforced by the prolongation or intensification of stimulation from particular sources, appears to be tripped off by an aversive condition

(imbalance) called perceptual curiosity. Incomplete perception may leave the person with uncertainty, which is reduced by exploratory responses designed to obtain additional information. The second type of motivation, diversive exploration, introduces stimulation from any interesting or entertaining sources. Specific and diversive exploration, as shown later, may be related to directed and autistic thinking, respectively.

Berlyne states that specific exploration can be reinforced only by information that is capable of reducing uncertainty; that is, information coming from the object to which the uncertainty relates. To repeat the generalization, specific exploration is postulated to be clearly related to directed thinking, while diversive explorations are more closely related to autistic thinking.

The principal determinants of specific exploration are labeled by Berlyne as collative variables (1965, pp. 245-247) with empirical referents such as "novelty," "change," "incongruity," and "complexity." To collative variables, Berlyne attributes two specific properties. First, they possess close links with the concepts of information theory, and they depend on collation (or comparison) of information from different stimulus elements. Secondly, collative variables entail conflict, which Berlyne defines as the simultaneous instigation of incompatible responses. The nature of conflict is deduced from a knowledge of what stimuli are acting on the organism and the behaviors they evoke individually. As envisioned by Berlyne, conflict is not something a person is in or not in. For the alive, awake individual there is a constant degree of conflict which will vary from moment to moment. Conflict is closely related to uncertainty (a core concept

of information theory). The principal difference is that uncertainty reflects probability of alternate responses, while conflict also depends on their absolute strengths.

Berlyne refers to the increasing body of experimental research (both Russian and Western) which leads to the conclusion that exploratory behavior is commonly accompanied by increased arousal. Arousal appears to be associated with general activating or energizing effects, similar to the long-established concept of drive. Drive increases when an organism is subjected to physiological disturbance, and may also be raised by external or internal stimuli which have been regularly paired with such disturbances. Motivating conditions aroused by the peripheral organs of the body may be called "sources of extrinsic motivation," and can actuate exploratory or epistemic behavior. Certain forms of intrinsic motivation also are capable of actuating exploratory or epistemic activity. This cognitive conflict depends primarily on the collative properties of the external environment when it is perceived as vague, hazy, and relatively incomplete.

Exploratory behavior appears to reduce drive resulting from exceptionally novel, surprising, complex or puzzling stimulus patterns. The act of exploration provides reinforcement, which facilitates the retention of the information obtained which consequently reduces the drive.[1] Such reinforcement would tend to strengthen the individual's

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[1]The reader should be aware of the fact that Berlyne has set out to be a rigorous theorist, maintaining the classical behaviorist notion of drive reduction, thus he has "externalized" much of the physiological sensations experienced by human beings. The only intrinsic motivation he permits in his system involves "cognitive conflict" which itself ends in the reduction of tension. This form of intrinsic motivation, of course, is unlike White's "effectance motivation" linked to the idea of competence (1960) but parallels Hunt's concept of "cognitive imbalance"(1959).

inclination to engage in exploratory activity in comparable situations.

On the symbolic level (where most of the educational encounter transpires) conflict may be due to discrepancies and/or inconsistent relations among symbolic processes. Resultant tension can only be reduced by modifying symbolic structures and injecting new information (a desired goal of teaching). A state of high drive induced by conflict related to the symbolic processes constitutes epistemic curiosity. This condition can be relieved by the acquisition of knowledge and therefore leads to epistemic behavior which includes directed thinking. The relation between exploratory behavior and epistemic behavior appears obvious.

Arousal may also result from a state of inordinately low stimulation, which we call boredom. Such a state may be relieved by receipt of stimulation from virtually any source, provided that it brings the collative properties of the environment to an optimal level. For example, a person bored by inactivity may become restless and take a walk, or watch a television program which really does not interest him. The individual in a state of boredom in a classroom may attempt to escape by daydreaming, doodling, or any other of a number of activities which very well may result in conflict with the teacher.

Conflict between incompatible symbolic response patterns (beliefs, attitudes, thoughts, ideas) is identified by Berlyne as conceptual conflict, which he hypothesizes to be a factor producing epistemic curiosity. Overloading of information-handling capacity may result in conceptual conflict. Berlyne acknowledges that this may be what Bruner, et al (1956) called cognitive strain (Bruner hypothesized that one of the reasons for developing cognitive strategies was to reduce

cognitive strain). Berlyne states that the degree of conceptual conflict is assumed to increase with: 1) the number of competing responses; 2) how nearly equal in strength the competing responses are; 3) the total absolute strength of the competing responses; and 4) degree of incompatibility between competing responses. He identifies six major types of conceptual conflict:

> Doubt which is the conflict between tendancies to believe and to disbelieve a proposition or between tendancies to ascribe and to deny reality to a phenomenon.
>
> Perplexity which occurs when there are factors inclining the person toward each of a set of mutually exclusive beliefs.
>
> Contradiction, an intense kind of conflict where the person is under the influence of factors that not merely favor but imperatively force on him two incompatible beliefs.
>
> Conceptual incongruity which is a matter of at least two properties and the reluctance to believe that they can be coupled. That is, a person believes that A and B never occur together, yet he is confronted with an object that possesses both (a fish that can walk on dry land).
>
> Confusion is produced by information with unclear implications.
>
> Irrelevance is especially related to human thought processes, for example when an irrelevant thought is allowed to survive even though it interrupts the processes.

Relieving conceptual conflict appears to be a result of directed thinking which has both information-rejecting and information-gathering aspects. The reduction of the tension caused by conceptual conflict appears to come about by the information provided by directed thinking.[2] Berlyne posits four conflict resolving methods:

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[2]Berlyne's comments on directed thinking are especially relevant. He does considerable amplification of the meaning of this concept in the Koch volume, discussed later in this paper.

disequalization, swamping, conciliation and suppression.

Several lines of evidence tend to confirm that conceptual conflict can generate epistemic curiosity and motivate epistemic behavior. Relief of conceptual conflict can provide reinforcement for the learning processes by which knowledge is acquired. Berlyne's experimental work took the postulated determinants of conceptual conflict and tested their effects on epistemic curiosity, measured through verbal reports. He relates the Russian studies of Morozova (1955) and her associates which were devoted to "interest" in school children. One intriguing criterion studied was the literature which interested children. The books most in demand raised questions, offered chances to guess answers and required thought on the part of the child. Most rejected books were simple purveyors of information.

Berlyne comments in his section on <u>discovery methods</u> in education that most new techniques rely heavily on stimulating independent discovery of facts and development of individual judgment. The student is not viewed as passive or absorbing; his curiosity has to be cultivated so that he will discover knowledge through his own activities and thus be stimulated and, subsequently, have the exhileration of possessing new knowledge (the agricultural vs. mining approach to education seems relevant). He says that discovery methods may cause children to assimilate material that previously might have been considered beyond them, and that these methods are primarily manipulation of conceptual conflict.

Berlyne alludes to the work of Suchman (1961), for whom discovery learning is equivalent to "inquiry methods," who began the classroom experience with a film in which some surprising physical

phenomenon was demonstrated. Then the children were encouraged to ask questions, and were directed to discover the most appropriate answer. Zankov (1957) reported of children being allowed to examine an object during a lecture, instead of the usual listening to the lecture alone, and the results appear related to discovery learning. Milerian (1960) studied transfer of skill from operating a lathe to operating milling and drilling machines. When the experience of the subjects proved to be inadequate for the new situation, they compared differences between the new task and the old operation, usually generalizing some practical course of action. Kersch (1958, 1962) studied the advantages of discovery methods over traditional methods in the teaching of math and supported the hypothesis that students using discovery methods are more motivated to learn.

Epistemic curiosity is usually stirred up by an experience which contradicts expectations or leaves the student perplexed. Berlyne states that the newer methods are aimed at fostering "understanding," and that there are signs of success. It seems apparent that understanding will tend to eliminate conceptual conflict, be reinforcing and thereby more readily retained by the student.

Berlyne discusses Piaget's equilibrium. In Piaget's view equilibrium is the main driving force of the whole perceptual and intellectual development, and is defined as an autonomous tendency for interacting processes to gravitate from lesser to greater equilibrium. Piaget calls this equilibration, and indicates that it refers to a kind of learning motivated by conflict, reinforced by conflict reduction. Equilibration depends upon a balance between assimilation and accomodation, and imbalance of either results in disequilibration.

Assimilation is a process that enables incoming stimulation to evoke a response appropriate to the previous learning of the organism. Accomodation involves processes whereby a person behaves in a way that fits what is in the external environment, and a deficiency may result in surprise or frustration.

In his Scientific American article, "Conflict and Arousal," Berlyne discusses the interest of psychology in certain aspects of behavior which hinge on collative stimulus properties (how novel, surprising, complex, puzzling or ambiguous a stimulus is). These factors can have a wide variety of motivational effects on behavior, even inducing fear and flight. Moderate amounts of unpredictable change are, however, sought out and welcomed. Cases in point are the types of behavior which we label as play or recreation. It appears that the nervous systems of higher animals are made to cope with stimulating environments which challenge capacities.

The collative properties of stimuli (that is, phenomena which accompany their perception) appear to have motivational significance because they give rise to conflict. If the nervous system of the organism were not able to handle collative stimuli, adaptive behavior would soon be impossible. To this end, perceptual and thought processes impose order on the external world by classifying, interrelating, interpreting, and organizing the information coming in through the sense organs (i.e., placing incoming cues relative to one another). Additional information may be sought through exploratory behavior. Berlyne states that there are indications that learning motivated by curiosity can give rise not only to particularly rapid and lasting acquisition of knowledge, but also to knowedge in which ideas are

fruitfully pieced together into coherant structures.

A state of high drive manifests itself in three ways: 1) it activates the organism as a whole; 2) it inclines the organism toward a particular class of behavior; and 3) it enhances learning by making the organism sensitive. Arousal and drive are closely related. An exceptionally high state of arousal impairs performance--an effect which has been attributed to "overmotivation." Berlyne states that different kinds of arousal are controlled by different centers in the brainstem (Lindsley's afferent reticular arousal system, 1957), and that changes in arousal are intimately connected with the reinforcement of learned responses. There appears to be a close relation between arousal and exploratory activity, usually evoked by novel, complex or ambiguous stimuli.

Berlyne reasons that if we may conclude that conflict can increase arousal and if arousal may be equated with drive, conflict will have to be added to the list of conditions from which high drive can result. In this line of thought, our view of motivation will be broadened considerably if we are obliged to accept conflict as an additional source of drive. This appears to imply that animals can be impelled to action and to the learning of new responses.

Conflict and information-theory variables as determinants of human perceptual curiosity, Berlyne's report in the Journal of Experimental Psychology, relates the results of a series of experiments on the integration of the theory of perception with general behavior theory. Such an integration would appear to require some account of the motivational factors underlying perception. Berlyne holds that the application of the concepts of drive and drive reduction to human

exploratory behavior demands some justification. He does not believe that Pavlov's theory of investigatory-reflex explains exploratory behavior, and denies that Gutherie's contiguity theory (that learning occurs when events happen close to one another in time or space) is adequate.

Berlyne's theoretical approach distinguishes perceptual and epistemic curiosity. A principal determinant of epistemic curiosity is the degree of learned conflict between the symbolic response aroused by a stimulus situation, which he relates to the information theorist's entropy or uncertainty. A case of such conflict is incongruity-conflict, aroused by incompatible characteristics. Surprise-conflict results when a stimulus pattern fails to confirm an expectation evoked by what preceded it. Berlyne's theory proposed that epistemic curiosity, which instigates a search for knowledge, increases with the number of previous gratifications (successful outcomes) of the drive in similar situations.

The method employed to demonstrate the truth value of the proposition was to use a tachistoscope, rigged to flash pictures for the Ss examination. Sixteen undergraduates participated, pressing a key for as long as they wanted to continue seeing a card. Each S signalled verbally for a picture change, having been told that the experiments were intended to show how interesting certain pictures were. The number of exposures was taken as an indication of the intensity of the drive aroused. The results tended to confirm Berlyne's theory, according to which curiosity increases with the number of previous opportunities to gratify it in similar circumstances, and the predicted importance of incongruity-conflict was vindicated.

The experiment was repeated with eighteen 5-year-old children. The results were the same except that the children exhibited more curiosity than the adults.

In Motivational problems raised by exploratory and epistemic behavior, a profound and far-ranging chapter in Volume Five of the Koch series, Psychology: The study of a science (1963, pp. 284-364), Berlyne elaborates much that has been introduced in the prior reviews. In his treatment of epistemic behavior Berlyne becomes especially lucid and relevant to this treatment of his theories.

Berlyne states that epistemic behavior refers to behavior whose function is to equip the organism with knowledge, by which he means structures of symbolic responses. Epistemic behavior is divided into three categories, namely, epistemic observation, consultation, and directed thinking.

Directed thinking consists of chains of symbolic responses, and has a special status among the three kinds of epistemic behavior. Observation and consultation generally occur in conjunction with directed thinking. The resultant knowledge ultimately is utilized through its participation in directed thinking.

Successive trials are means of securing information about the probably consequences of performing similarresponse in the future. Stored information will be knowledge if the effects on future behavior are exerted through symbolic responses, representing the external stimulus events from which they derive.

If a response is executed for information only, it can often be fulfilled by a curtailed version, e.g. a lick instead of a taste. If a person needs to recall and anticipate the consequence of a previously

executed response, an even more curtailed version may be satisfactory. Under appropriate circumstances an internal or implicit response (recalling prior experience with the object which does not now need to be present) is all that is required. Such are the responses on which directed thinking depends.

Epistemic behavior generally is initiated by a specific dissatisfaction. The knowledge necessary to satisfy specific epistemic curiosity needs to be directly related to the original dissatisfaction. The receipt of information cannot be rewarding without the initial conflict, in view of the fact that the psychological function of information is to reduce conflict.

The extrinsic-intrinsic dichotomy is applicable to epistemic behavior. In the intrinsic case, knowledge is welcomed for the contribution it makes toward the attainment of a practical goal. On the other hand, in the intrinsic case, knowledge is satisfying in itself and for its power to reduce conflict. The kind of conflict which underlies epistemic curiosity is termed conceptual conflict by Berlyne. Conflicts are inseparable from the essence of thinking, which consists of processes that would result in overt action if not cut short before motor action begins. In this conflict there is a factor which initiated the process and another factor which intervenes and prevents its progress, e.g. these factors make contradictory demands on the individual's nervous system, and conflict results.

Conceptual conflict is also implied by the nature of intelligence which handles highly abstract concepts in thinking. These abstract concepts require more and more detail to be added before a clear overt response occurs. Thought objects become gradually less abstract.

Beginning with elements that specify a minimum of properties (dimensions), more and more details are supplied and the area of vagueness is narrowed. In the language of information theory, as interpreted by Berlyne, thinking begins with a high degree of uncertainty, which is then diminished step by step. At the point of uncertainty (vagueness) there is a high degree of conflict which results in curiosity. Conflict and curiosity are reduced progressively until one line of behavior becomes dominant.

Berlyne states that epistemic curiosity plays a part even when knowledge is sought as a means to a mercenary end. The work of Zajonc and Morrissette (1960) is utilized to show how receptiveness to offered information may vary with degree of uncertainty. The more uncertain subjects showed a tendancy to change their personal opinions when confronted with opinion of an "expert." Berlyne's own work (1954) with high school subjects demonstrated that an increase in knowledge may result from an aroused high level of epistemic curiosity. In another experiment, Berlyne (1962) hypothesized that epistemic curiosity would increase the number of alternative responses, and the hypothesis was confirmed.

Berlyne believes that the stress on conceptual conflict may have important implications for teachers. Instead of holding to the Herbartian notion that new materials should correlate with the prior experiences of students (the "apperceptive mass"), Berlyne says that a head-on clash between new material and prior experience may best motivate intellectual inquiry and accomplishment. He says that there are areas where this may not be applicable, for instance, mathematics which builds on previously learned concepts in a chain-step fashion.

To support his contention of the pedagogical importance of curiosity, Berlyne cites an experiment conducted by J. S. Bruner (1961) where children were to locate cities using only a knowledge of the physical features and natural resources of a region. They later compared their hypothesized locations with actual locations. The experiment engendered zeal, interest and better retention. Berlyne attributes this to epistemic curiosity induced by conflict among the multitude of possible choices and doubts about how near the inferences would correspond to actuality.

Conclusions

This paper by no means represents the work of Berlyne *in toto*, nor was it purported to do so. Rather it is a representation of four dimensions of the work of this important neobehavioristic psychologist, especially as the work is related to the educational encounter of children. The interpretations necessarily leave out many details which contribute to a fuller understanding. The student, therefore, is urged to initiate personal inquiry into the abundant available literature.

The current emphasis on curiosity appears to be a reflection of the rising need to understand more about the intellectual processes of human beings. For no other profession is this understanding of human intellect quite as pressing as it is for the teacher. An understanding of human thought processes certainly should lead to more effective teaching procedures, and, quite possibly, to radical curriculum evaluation and restructuring, especially in the education of the very young. This restructuring appears to be in the future of education, as we seem on the brink of public supported kindergarten. This is a

need often voiced by teachers of children who have been called "culturally deprived." When it comes, and come it will, the opportunity to educate children at an earlier level should be planned carefully. A comprehensive understanding of how the minds of children develop and work seems an absolute necessity for this inevitable restructuring of education. One important dimension of an intelligent approach to the necessary understanding of intelligence most certainly is going to entail the effective use of curiosity in the educational encounter. A significant resource will be Daniel E. Berlyne, his theories, writings, and research.

REFERENCES

Berlyne, D. E. An experimental study of human curiosity. British Journal of Psychology, 1954, 45, 256-65.

Berlyne, D. E. Conflict and information-theory variables as determinants of human perceptual curiosity. Journal of Experimental Psychology, 1957, 53, 399-404. Reprinted in Harry Fowler, Curiosity and exploratory behavior. New York: McMillan, 1965. Pp. 191-9.

Berlyne, D. E. Uncertainty and epistemic curiosity. British Journal of Psychology. 1962, 53, 27-34.

Berlyne, D. E. Motivational problems raised by exploratory and epistemic behavior. In Sigmund Koch, Psychology: A study of a science. Vol. V: The process areas, the person, and some applied fields: Their place in psychology and in science. New York: McGraw-Hill, 1963. Pp. 284-364.

Berlyne, D. E. Structure and direction in thinking. New York: Wiley, 1965.

Berlyne, D. E. Conflict and arousal. Scientific American, August 1966. Pp. 82-7.

Bruner, J. S. The process of education. Cambridge, Mass.: Harvard University Press, 1961.

Bruner, J. S., Jacqueline J. Goodnow and George A. Austin. A study of thinking. New York: Wiley, 1956. Paperback: New York: Science Editions, 1962 (Fourth Printing, 1966).

Kersh, B. Y. The adequacy of "meaning" as an explanation for the superiority of learning by independent discovery. Journal of educational psychology. 1958, 49, 282-92.

Kersh, B. Y. The motivation effect of learning by directed discovery. Journal of educational psychology. 1962, 53, 65-71.

Lindsley, D. B. Psychophysiology and motivation. In Jones, M. R. (ed.) Nebraska symposium on motivation, 1957. Lincoln: Univer. of Nebraska Press. Pp. 44-105.

Milerian, E. A. Psychological characteristics of the transfer of technical skills in older school children. Vop. Psikhol., 1960, 11(2), 51-9. (English translation: B. Simon and J. Simon. Educational psychology in the U.S.S.R. Stanford, Calif.: Stanford Univer. Press, 1963).

Morozova, N. G. The psychological conditions for the arousal and modification of interest in children in the process of reading popular scientific literature. Izvestiia Akad. Pedag. Nauk.

Piaget, J. La psychologie de l'intelligence. Paris: Colin, 1947. (The psychology of intelligence. London: Routledge & Kegan Paul, 1950. Reprinted in paperback: ILP No. 222. Totowa, N.J.: Littlefield, Adams and Co.)

Suchman, J. R. Inquiry training: building skills for autonomous discovery. Merrill-Palmer Quart., 1961, 147-69.

Zajonc, R. B., and Morrissette, r. The role of uncertainty in cognitive change. Journal of abnormal and social psychology. 1960, 61, 168-75.

Zankov, L. V. Combination of the verbal and the visual in teaching. Vop. Psikhol., 1957, 3(6), 40-57. (English translation: B. Simon and J. Simon (eds.) Educational Psychology in the U.S.S.R. Stanford, Calif.: Stanford Univer. Press, 1963).